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(54) Mechanical and electrical keying arrangement for replaceable ink cartridge

(57) A replaceable ink cartridge (12) for an inkjet printer (10) enables both mechanical and electrical keying. The inkjet printer (10) includes a receptacle (14) for receiving the ink cartridge (12), which receptacle (14) includes a fluidic coupler (28), an electrical connection (30), and a mechanical keying feature (66) for accepting only ink cartridges (12) containing a first class of compatible ink types and for rejecting ink cartridges (12) containing a second class of incompatible ink types. The replaceable ink cartridge (12) includes a casing with a fluidic coupler (20), a reservoir (22) connected to the fluidic coupler (20) for holding an ink supply and an electrical connector (24). A memory (26) is coupled to the electrical connector (24) and stores a parameter from which an identity of an ink stored in the reservoir (22) can be identified. A physical key (62,64) is positioned on a leading portion of the casing of the replaceable ink cartridge (12). A successful insertion of the casing into a receptacle (14) in the printer (10) indicates that the ink type in the reservoir (22) is within the first class of compatible ink types, but not that it is usable with the printer (10). The printer (10) determines usability by reading out the parameter from the memory (26) and determining that the ink identity is one that can be used with the printer (10).

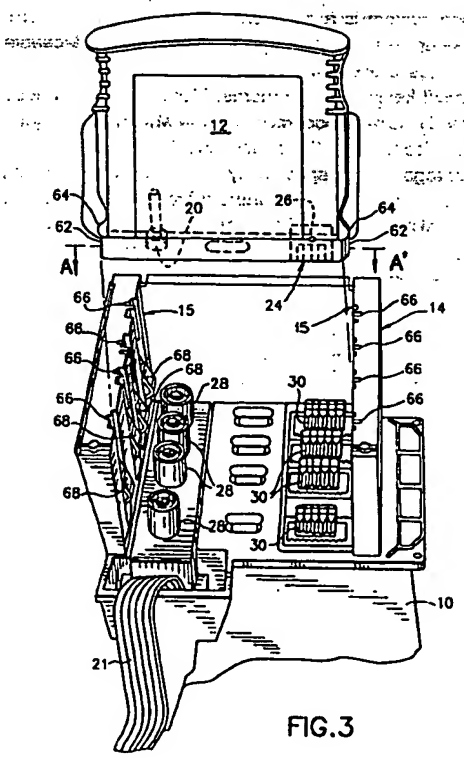

FIG.3

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Description

FIELD OF THE INVENTION

This invention relates to inkjet printers and the like and, more particularly, to a mechanical and electrical keying system which assures that an inkjet printer will only operate when a replaceable ink cartridge has been inserted that contains ink which is compatible with the printer.

BACKGROUND OF THE ART

The prior art has suggested that replaceable inkjet printheads and ink cartridges incorporate a parameter memory for storage of operating parameters that are used to control print operations. For instance, U.S. Patent 5,138,344 to Ujita stores information on a replaceable ink cartridge, which information relates to control parameters for the printer. U.S. Patent 5,365,312 to Hillmann et al. describes the use of a memory device integral with an ink reservoir for storage of ink consumption data. European Patent EP 0 720 916 describes an ink reservoir which includes a memory for storage of data regarding the identity of the ink supply and its fill level.

The problems of compatibility between replaceable ink cartridges and printers which receive those ink cartridges have been addressed in the prior art by providing mechanical keying features which prevent insertion of replaceable ink cartridges that contain inks that are incompatible with the printer. So long as a printer only used a single replaceable ink cartridge, the mechanical keying system is a sufficient solution to the problem. However, in full-color inkjet printers, four replaceable cartridges are employed, requiring four different mechanical keying arrangements. More recently, various types of inks have become available which are designed to be used for specific applications. For instance, some ink categories are specifically designed for application to plain paper print jobs wherein high-edge acuity is a principal requirement. Other ink types have been developed for use with glossy-finish media sheets, etc. Accordingly, mechanical keying methods have become increasingly complex.

It has been suggested that an electronic keying method be employed wherein a parameter stored in a memory module mounted on an ink cartridge would contain an identifier that would enable a printer to know if the ink contained in the cartridge was compatible or incompatible. However, if a cartridge containing an incompatible ink is allowed to couple to a fluidic connector in the printer, before the electronic interrogation of the memory is enabled, there is a likelihood that some of the incompatible ink will contaminate at least the fluidic interconnection to the printer. In such case, if the ink is highly incompatible (e.g., creates a precipitate when combined with a previously used ink), is a wrong color, manifests a viscosity which will plug the orifices of a print head, etc.., such a coupling can result in severe printer damage.

Accordingly, it is an object of the invention to provide a keying system which prevents insertion of a replaceable ink cartridge into a printer if the ink cartridge contains a severely incompatible ink.

It is another object of this invention to provide a keying system for a printer which allows an initial insertion of a replaceable ink cartridge if the ink cartridge contains either a compatible ink or an ink which, while incompatible, will not create irreversible printer damage as a result of a fluidic coupling thereof to the printer.

SUMMARY OF THE INVENTION

A replaceable ink cartridge for an inkjet printer enables both mechanical and electrical keying. The inkjet printer includes a receptacle for receiving the ink cartridge, which receptacle includes a fluidic coupler, an electrical connection, and a mechanical keying feature for accepting only ink cartridges containing a first class of compatible ink types and for rejecting ink cartridges containing a second class of incompatible ink types. The replaceable ink cartridge includes a casing with a fluidic coupler, a reservoir connected to the fluidic coupler for holding an ink supply and an electrical connector. A memory is coupled to the electrical connector and stores a parameter from which an identity of an ink stored in the reservoir can be identified. A physical key is positioned on a leading portion of the casing of the replaceable ink cartridge. A successful insertion of the casing into a receptacle in the printer indicates that the ink type in the reservoir is within the first class of compatible ink types, but not that it is usable with the printer. The printer determines usability by reading out the parameter from the memory and determining that the ink identity is one that can be used with the printer.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic representation of a printing system, showing an ink cartridge of the present invention which forms a fluid interconnect and an electrical interconnect with the printing system.

Fig. 1a is a schematic representation of certain parameters stored in a memory mounted on the ink cartridge of the present invention

Fig. 2 is a perspective view of an inkjet printer, with cover removed, which incorporates the ink cartridge of the present invention.

Fig. 3 is an ink supply receptacle of the type used in the printer of Fig. 2, shown broken away, with an ink cartridge positioned for insertion thereinto.

Fig. 4 depicts a simplified sectional view, partially broken away, taken across line A-A' of Fig. 3 with the ink cartridge installed in an ink cartridge receptacle of Fig.3.

Fig. 5 illustrates a logic flow diagram of the effect of

the mechanical and electronic keying of the invention on a receiving inkjet printer.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 schematically depicts an inkjet printer 10 that includes an ink cartridge 12 which incorporates the invention. Inkjet printer 10 further includes an ink cartridge receiving station 14 which comprises a plurality of cartridge-receiving receptacles 15. An inkjet printhead 16 and a print controller 18 (e.g., a microprocessor) are also included with an inkjet printer 10. Printing is accomplished by printer 10 causing ejection of ink from printhead 16 under control of print controller 18.

Printhead 16 is connected to controller 18 by an electrical link 19. Ink is provided to printhead 16 by way of fluid conduit 21 which fluidically connects to printhead 16 to ink cartridge receiving station 14. Ink container 12 includes a fluidic coupler 20 which is in fluid communication with fluid in ink reservoir 22. Ink cartridge 12 further includes a plurality of electrical contacts 24 which are electrically connected to a memory 26.

Fluidic coupler 20 and electrical contacts 24 allow ink cartridge 12 to reliably interconnect with a fluid inlet coupler 28 and electrical contacts 30, respectively, associated with receptacle 15. Receptacle 15 enables ink to be transferred from ink reservoir 22 to printhead 16, via fluid conduit 21. In addition, receptacle 15 allows the transfer of information between memory 26 and print controller 18 via an electrical link 32.

Fig. 2 depicts a perspective view of inkjet printer 10, with its cover removed, containing plural ink cartridges 12. Printer 10 includes a tray 40 for holding a paper supply. When a printing operation is initiated, a sheet of paper from tray 40 is fed into printer 10, using a sheet feeder (not shown). During printing, paper sheets pass through a print zone 42 whereupon a scanning carriage 44, containing one or more printheads 16, is scanned across the sheet for printing a swath of ink thereon. The sheet of paper is stepped through the print zone 42 as the scanning carriage 44 prints a series of swaths of ink to form images thereon. After printing is complete, the sheet is positioned into an output tray 46 and the process repeats.

Scanning carriage 44 moves through print zone 42 on a scanning mechanism which includes a slide rod 48. A positioning means, such as a coded strip (not shown), is used in conjunction with a photo detector in scanning carriage 44 for precisely positioning scanning carriage 44. A stepper motor (not shown), connected to scanning carriage 44 via a drive belt and pulley arrangement, is used for transporting scanning carriage 44 across print zone 42.

Scanning carriage 44 in Fig. 2 is shown positioned at a nonprinting position, disposed adjacent print zone 42. The nonprinting position is known as a "service station" which maintains printhead 16 to assure optimum print quality over time. Each of printheads 16 is coupled by a cable (not shown) to print controller 18 that, in turn, controls the print actions thereof.

The present invention relates to apparatus for enabling ink container 12 to be received within a receptacle 15 and to operate with printer 10 only if the ink contained within reservoir 22 is of a compatible type to that utilized by printer 10. As will be understood from the description below, a combination of mechanical and electrical keying is used to accomplish the invention. However, before describing details of the keying arrangement, further description of the structure of ink container 21 and receptacle 15 will be considered.

Ink cartridge 12 is referred to as an off-axis ink supply because it is spaced from a scan axis along which scanning carriage 44 moves. Once ink cartridge 12 is properly inserted and latched into place in a receptacle 15, electrical, mechanical and fluidic interfacing is accomplished with printer 10. Ink passes through the fluid interface in receptacle 15, through fluid conduit 21 (e.g., tubing which fluidically connects ink containers 54, 56, 58 and 60) to corresponding printheads 16 on print scanning carriage 44.

Ink cartridge 12 contains a supply of ink which is either (i) from a first class of inks that are compatible with the receptacle into which ink cartridge 12 is to be inserted or (ii) from a second class of inks that are incompatible. The first class of inks are those which, if brought into contact with a fluidic connector in the receptacle will not damage printer 10. The second class of inks are those which, if allowed into contact with the fluid connector will cause severe damage. Such inks may be of the type which precipitate upon mixing with a previous ink connected to the fluidic connector, have a different colorant, a different viscosity, etc.. For instance, it is critical to prevent mixing of black and color inks in this system.

In Fig. 3, ink cartridge 12 is depicted, positioned for insertion into a receptacle 15 within ink cartridge receiving station 14. Each cartridge 12 includes an aligning/guide feature 62 and a latch feature 64 which provide both alignment, latching and keying functions. The aligning/guide features 62 are preferably positioned on opposite sides of ink cartridge 12. Corresponding aligning feature 66 are disposed at opposite ends of each receptacle 15. The use of aligning/guide 62 on opposite ends of cartridge 14 eliminates any need for partition walls between cartridges 12 during insertion.

Ink cartridge 12 has an elongate cross section perpendicular to the direction of its insertion into receptacle 15. Aligning features 62 are positioned at opposite ends, with the elongate shape of the cartridge maximizing the distance between the aligning features. Placing the features at these locations minimizes the angular variation between the ink cartridge and the receptacle during insertion, improves alignment of fluid outlet 20 to fluid inlet 28 and improves alignment of connector 24 to connector 30. However, the narrow ends of ink cartridge 12 allow only a minimal number of mechanical keying combina-

tions. Cartridge 12 needs to be kept narrow to minimize the space occupied by supply station 14. This limitation is resolved with an electronic keying system that enhances the number of keying combinations (to be discussed below).

Aligning/guide features 62 provide a keying function to insure that only a cartridge 12, containing ink of the class which will not create damage to a fluidic coupler 28, may be inserted into a receptacle 15. Such class of inks may not all be usable within printer 10, but will not damage the fluidic intercoupling means used to couple cartridge 12 into printer 10. Should a cartridge 12 include ink that will damage printer 10, aligning/guide features 62 prevent any insertion of a cartridge 12 into a receptacle 15.

Once ink cartridge 12 is properly aligned and inserted into receptacle 14 (assuming that the keying arrangement enables such insertion), a latching feature 68 engages a corresponding latching feature 64 on ink cartridge 12 to latch ink cartridge 12 into a receptacle 15. At such time, fluid coupler 28, associated with receptacle 15, engages the corresponding fluidic coupler 20 on ink cartridge 12 to allow a fluid flow into printer 10.

Insertion of ink cartridge 12 into receptacle 15 also forms an electrical interconnect between the cartridge 12 and receptacle 14. More specifically, electrical contacts 24 associated with cartridge 12 engage corresponding electrical contacts 30 associated with receptacle 15 to allow information to be transferred between print controller 18 and memory 26.

Fig. 4 depicts a sectional view of ink cartridge 12 taken across line A-A in Fig. 3. Fig. 4 illustrates the interaction between aligning/guide features 62 on ink cartridge 12 and keying features 66 on receptacle 15. Keying features 66 are disposed on a first side 70 and a second side 72 of receptacle 15. First and second sides 70 and 72 are positioned at opposite ends of receptacle 15 and aligning/guide features 62 are disposed at opposite ends of cartridge 12. In side 72, projections 74 are variously positioned within keying features 66 to enable reception of a cartridge 12 which incorporates a mating physical keying feature. Accordingly, unless a cartridge 12 includes such a mating physical feature, it is prevented from insertion into a receptacle 15, thereby preventing any coupling between fluidic couplers 20 and 28.

Further details of the mechanical guiding and aligning features are discussed in the following copending U. S. Patent Applications: Model No. 08/566,833, filed December 4, 1995; Model No. 08/791,290, filed January 30, 1997 and Model No. 08/789,957, filed January 30, 1997, all assigned to the same Assignee as this application. The disclosure of each of the aforesaid copending patent applications is incorporated herein by reference.

Returning to Fig. 1a, a schematic view of memory 26 illustrates a plurality of data segments stored therein which contain parameters for control of printer 10. One such parameter 90 enables an identity of ink contained within reservoir 22 to be determined by print controller 18. It is preferred that the parameter be a model number assigned to cartridge 12 by the manufacture. At least a portion of that model number will then include a value which unambiguously identifies the specific ink within the reservoir 22. Thus, when cartridge 12 is fully inserted into a receptacle 15 and connection is made between electrical contacts 24 and 30, print controller 18 is enabled to read out the model number from memory 26 and to identify the specific ink type within reservoir 22.

As will be recalled, electrical interconnection between contacts 24 and 30 cannot be made (by virtue of the mechanical keying, described above) if the ink within reservoir 22 is within a class of seriously incompatible inks. Thus, the electrical interconnection only occurs upon successful insertion of a cartridge 12. At such time, controller 18 determines, by analysis of ink identity parameter 90, the specific ink type in cartridge 12. If the ink type is compatible with printer 10, controller 18 enables further use of cartridge 12. If the ink is determined to be not a compatible type, controller 18 issues a signal which causes display of a message to a user indicating, at the least, a warning that the ink is incompatible with further operations of printer 10. The electronic keying feature may also provide a warning that an ink container, for instance, contains pressurized ink (which may cause long term printer damage) rather than ink at ambient pressure which the printer is designed to accept.

Fig. 5 illustrates a logic flow diagram of the effect of the mechanical and electronic keying on a receiving inkjet printer. As above indicated, the ink cartridge container may contain ink from the above-mentioned first class of inks, i.e., inks that do not have severe incompatibility problems, or the second class of inks, i.e., inks which exhibit serious incompatability with those to be used on the printer, e.g., the colorant (cyan, magenta, yellow, black, red, etc.) is not the same as is to be received into a receptacle. If the cartridge contains ink of the second class, the mechanical keying prevents its insertion into a receptacle.

If the cartridge contains an ink from the first class, the mechanical keying enables insertion of the cartridge into the receptacle. Then the system reads a model number from the cartridge memory and determines if the correct first class of ink is being installed. Thus, small differences in ink composition or differences in the internal construction of the ink cartridge would determine the correct first class. If not correct, the system blocks printing; otherwise, the system begins printing. An optional system behavior would be to allow the user to override the blocking of use of the ink cartridge if the ink will not do any long term damage to the printing system.

As an alternative, printer 18 can also disable further actions of printer 10 until cartridge 12 is changed. The user message is preferably displayed via a connected host processor that includes a display terminal.

As can be seen from the above, a cartridge 12 will be received into a receptacle 15 only if it contains an ink which falls into a class of inks that will not damage printer 10 as a result of an initial installation. Once received into a receptacle 15, a determination of the ink type is made by controller 18 which allows further use of ink from cartridge 12 only if the ink is fully compatible with printer 10. Otherwise, further use of cartridge 12 is inhibited. The combined mechanical/electrical keying enables a wide range of inks to be discriminated by printer 10 and avoids the need for complex mechanical keying systems.

It should be understood that the foregoing description is only illustrative of the invention. Various alternatives and modifications can be devised by those skilled in the art without departing from the invention. Accordingly, the present invention is intended to embrace all such alternatives, modifications and variances which fall within the scope of the appended claims.

Claims

1. A replaceable ink cartridge (12) for an inkjet printing system (10) having a receptacle (14) positioned to receive an ink cartridge (12), the receptacle (14) including both fluidic coupler means (28) and electrical connection means (30), the receptacle (14) further including a mechanical key feature (66) for accepting only ink cartridges (12) containing a first class of compatible ink types and for rejecting ink cartridges (12) containing a second class of incompatible ink types, said replaceable ink cartridge (12) comprising:

   a casing including a fluidic coupler (20), a reservoir (22) connected to said fluidic coupler (20) for holding an ink and an electrical connector (24);

   a memory (26) coupled to said electrical connector (24), for storing an identity parameter from which an identity of an ink stored in said reservoir (22) can be identified;

   key means (62,64) positioned on a portion of said casing, successful insertion of said casing into a receptacle (14) indicating that an ink type in said reservoir (22) is within said first class of compatible ink types, but not that it is usable with said printer (10), usability being determined by a decoding of said identity parameter by said printer (10) and a determination that the ink identity is one that can be used with the printer (10).

2. The replaceable ink cartridge (12) as recited in claim 1, wherein said key means (62,64) comprises a physical shape which is formed so that upon an attempted insertion of said leading portion of said ink cartridge (12) into said receptacle (14), insertion can only be accomplished if said ink in the reservoir (22) of said cartridge (12) is within said first class of compatible ink types.

3. The replaceable ink cartridge (12) as recited in claim 1, wherein said key means (62,64) comprises a physical shape which is formed so that upon an attempted insertion of said leading portion of said ink cartridge (12) into said receptacle (14), insertion cannot be accomplished if said ink in the reservoir (22) of said cartridge (12) is within said second class of incompatible ink types.

4. The replaceable ink cartridge (12) as recited in claim 1, wherein said identity parameter is a model number assigned to said replaceable ink cartridge (12).

5. A printing system (10) for receiving a replaceable ink cartridge (12), said replaceable ink cartridge (12) comprising a casing including a fluidic coupler (20), a reservoir (22) connected to said fluidic coupler (20) for holding an ink, an electrical connector (24), a memory (26) coupled to said electrical connector (24), for storing an identity parameter from which an identity of an ink stored in said reservoir (22) can be identified, and key means (62,64) positioned on a portion of said casing and identifying a class of ink types to which the ink in said reservoir (22) belongs, said printer system (10) comprising:

   a receptacle (14) positioned to receive an ink cartridge (12), the receptacle (14) including both fluidic coupler means (28) and electrical connection means (30), the receptacle (14) further including a mechanical key feature (66) for accepting only ink cartridges (12) containing a first class of compatible ink types and for rejecting ink cartridges (12) containing a second class of incompatible ink types; and

   processor means (18) for reading said identity parameter from said memory (26) via said electrical connector (24), upon successful insertion of said casing into said receptacle (14), and for determining from the identity parameter if ink in said reservoir (22) is an ink that can be used with the printer (10) and only if said ink can be used in said printer (10), enabling full use of said cartridge (12).

6. The printing system (10) as recited in claim 5, wherein if said identity parameter enables said processor means (18) to determine that said ink is not to be used in said printer (10), said processor

means (18) issues a signal which at least causes a caution message to be displayed to a user.

7. The printing system (10) as recited in claim 5, wherein said mechanical key feature (66) comprises a physical shape which is formed so that upon an attempted insertion of a leading portion of an ink cartridge (12) into said receptacle (14), said key means (62,64) on said leading portion enables insertion only if ink in the reservoir (22) of said cartridge (12) is within said first class of compatible ink types.

8. The printing system (10) as recited in claim 5, wherein said mechanical key feature (66) comprises a physical shape which is formed so that upon an attempted insertion of a leading portion of an ink cartridge (12) into said receptacle (14), said key means (62,64) on said leading portion preventing insertion if ink in the reservoir of said cartridge (12) is within said second class of incompatible ink types.

9. The printing system (10) as recited in claim 5, wherein said identity parameter is a model number assigned to said replaceable ink cartridge (12).

10. The printing system (10) as recited in claim 5, wherein said identity parameter causes said processor means (18) to issue a warning to a user if the ink cartridge (12) contains an ink type within said first class, but said identity parameter denotes a feature that does not match a feature required by said printing system (10).

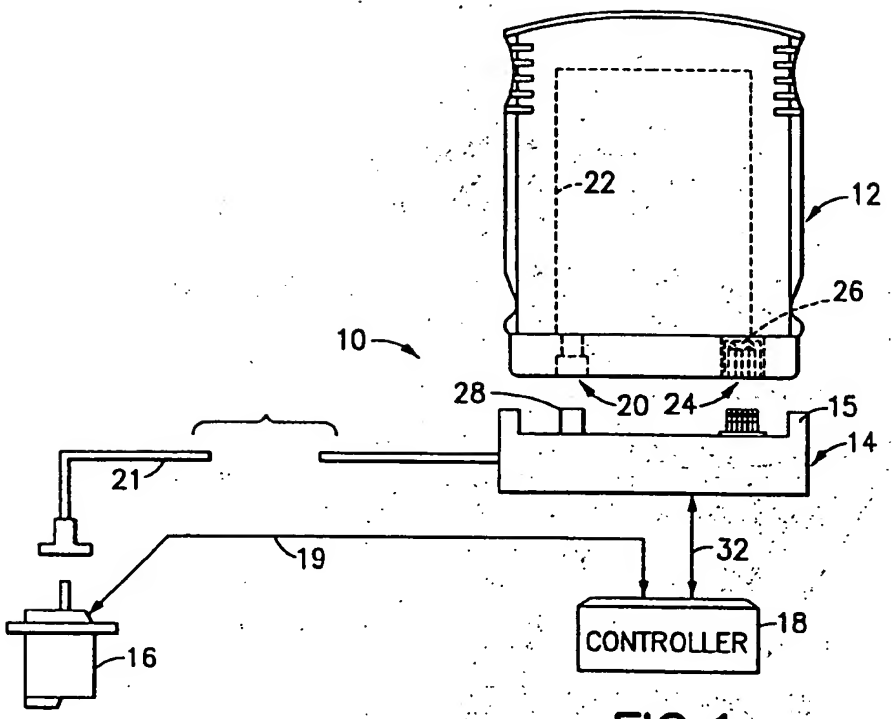

22
12
26
10
28
20
24
15
14
21
19
32
CONTROLLER
18
16

FIG.1

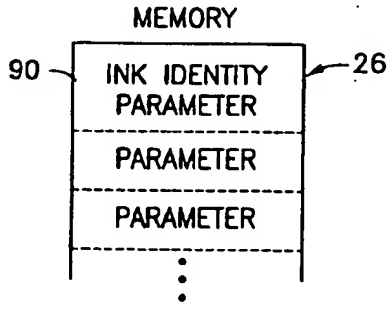

MEMORY
90
INK IDENTITY PARAMETER
26
PARAMETER
PARAMETER

FIG.1a

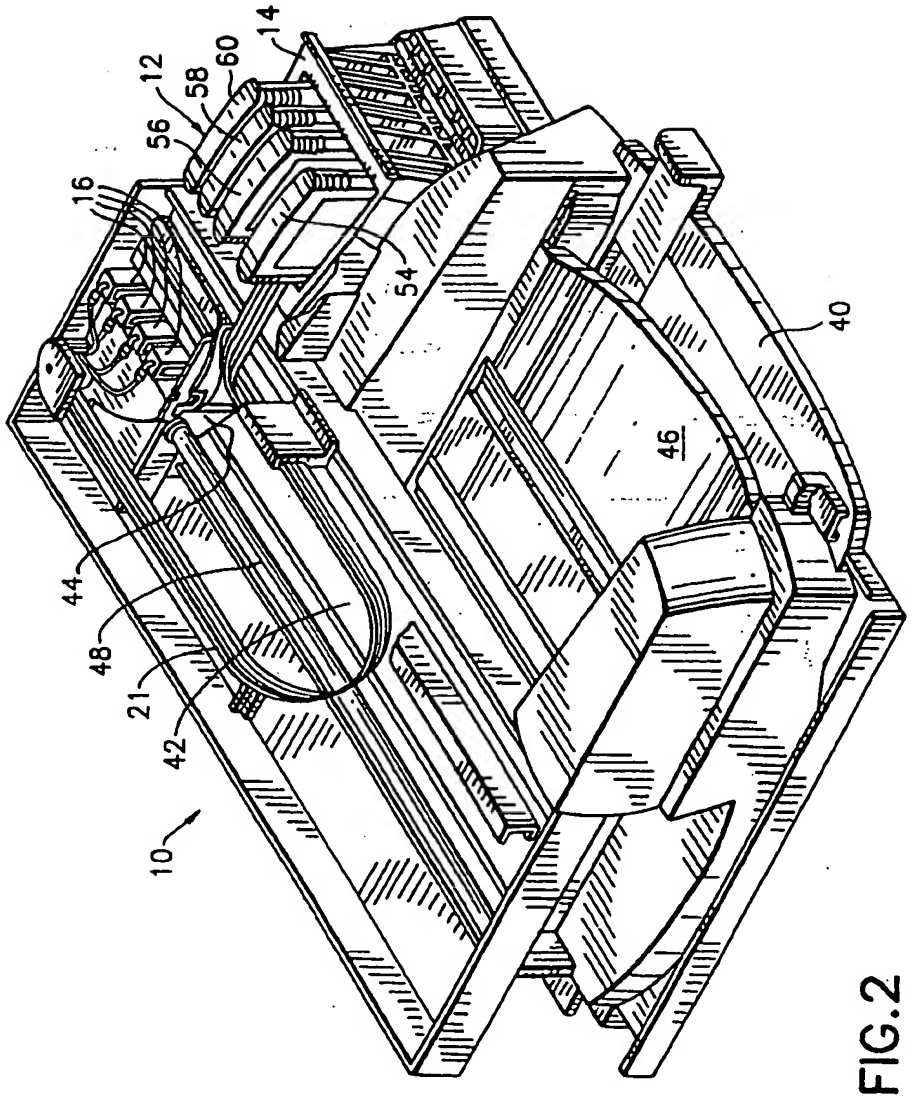
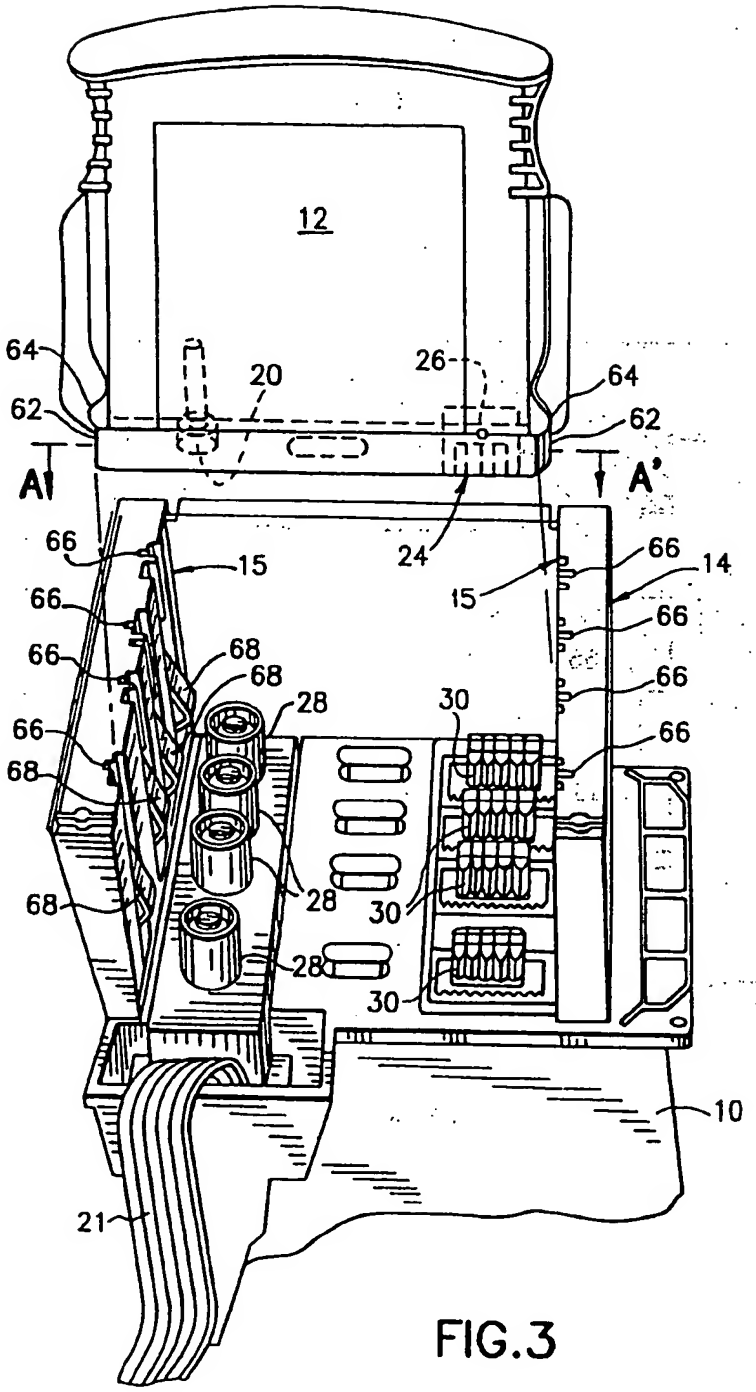


FIG.2


12
64
62
20
26
64
62
A
A'
66
15
24
15
66
14
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21

FIG.3

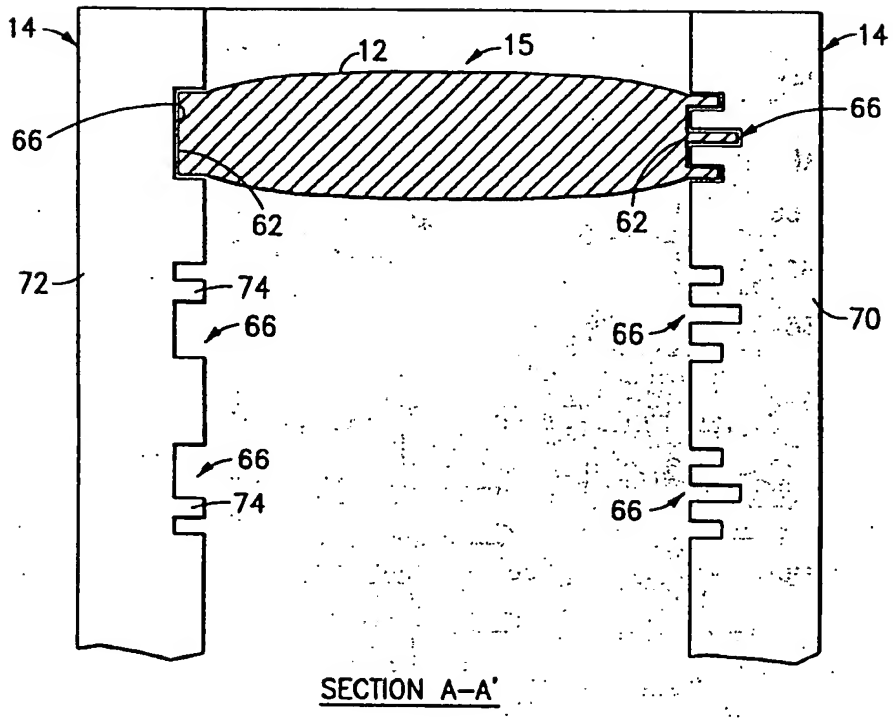

FIG.4

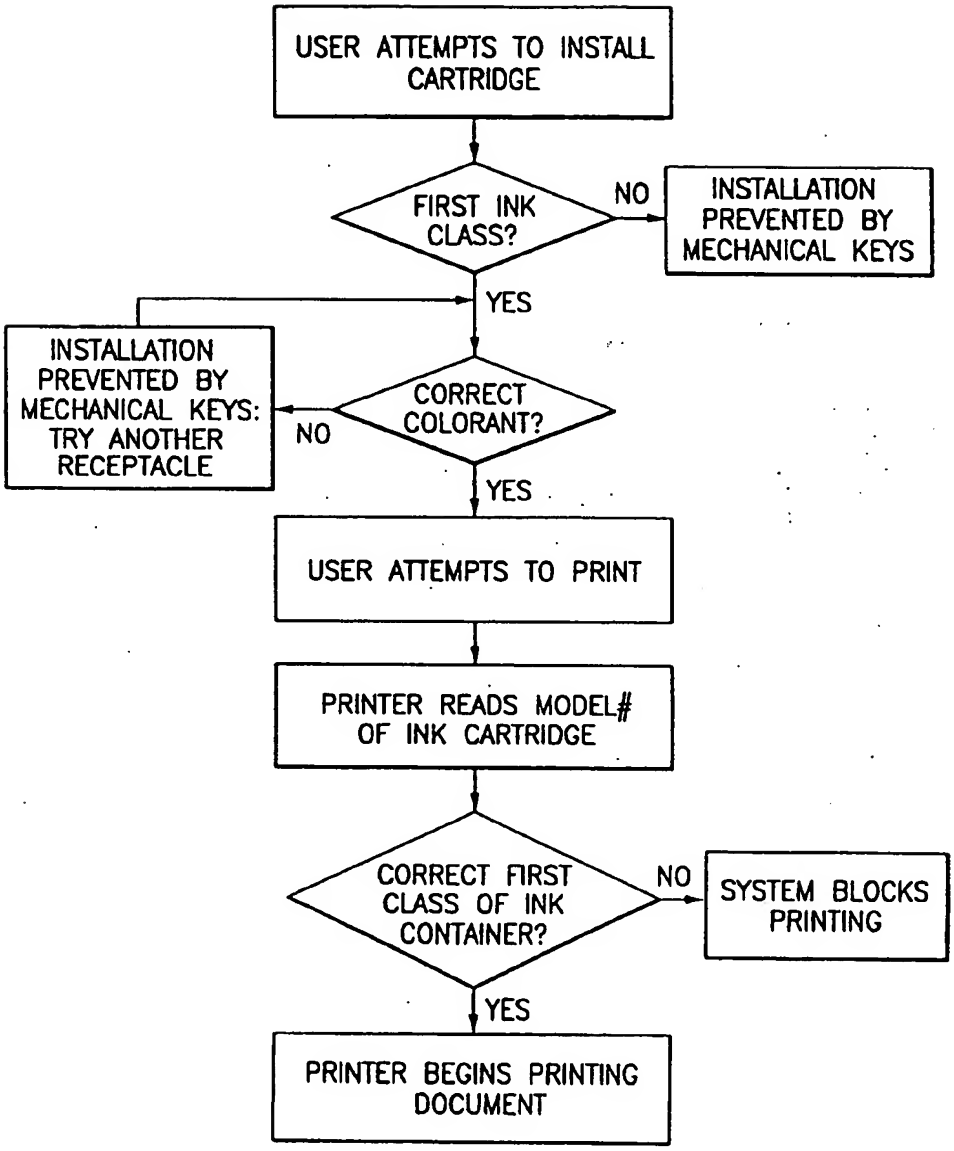
USER ATTEMPTS TO INSTALL CARTRIDGE
FIRST INK CLASS?
NO
INSTALLATION PREVENTED BY MECHANICAL KEYS
YES
INSTALLATION PREVENTED BY MECHANICAL KEYS: TRY ANOTHER RECEPTACLE
CORRECT COLORANT?
NO
YES
USER ATTEMPTS TO PRINT
PRINTER READS MODEL# OF INK CARTRIDGE
CORRECT FIRST CLASS OF INK CONTAINER?
NO
SYSTEM BLOCKS PRINTING
YES
PRINTER BEGINS PRINTING DOCUMENT

FIG.5